

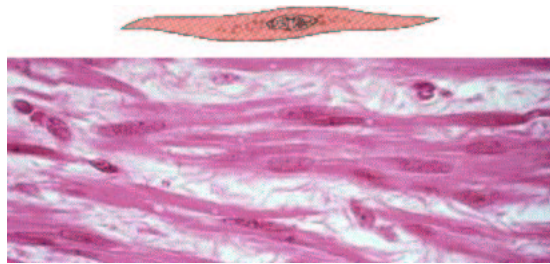
Muscular System
ANS 215
Physiology and Anatomy of
Domesticated Animals

I. Primary Functions (45 – 50% of body mass)

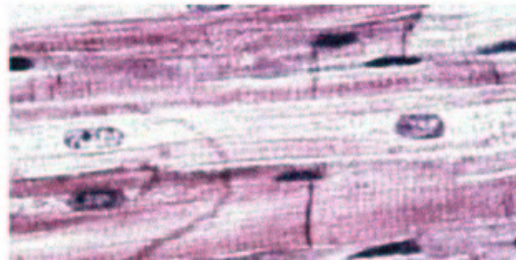
- A. Movement
 - 1. Blood
 - 2. Ingesta/excreta
 - 3. Gametes/conceptus
- B. Support
- C. Generation of body heat

II. Classifications

- A. Smooth
 - 1. No striations
 - 2. Individual cells are spindle shaped with centrally located nuclei
 - 3. Regulated by the autonomic nervous system
 - 4. Located in visceral structures
 - 5. Aggregates of myofilaments are composed of actin and myosin
 - 6. Filaments are not arranged in order

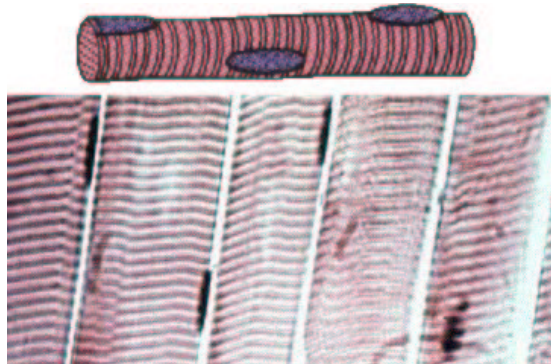


- B. Cardiac
 - 1. Found only in the heart
 - 2. Regulated by the autonomic nervous system
 - 3. Shows striations characterized by alternating white and dark bands
 - 4. Composed of elongated, branching cells with irregular contours at junctions with other cells
 - 5. Boundary area where cells meet is called intercalated disk
 - 6. This specialized structure facilitates transmission of nerve impulses
 - 7. Each cell has a nucleus (sometimes 2) that is centrally located



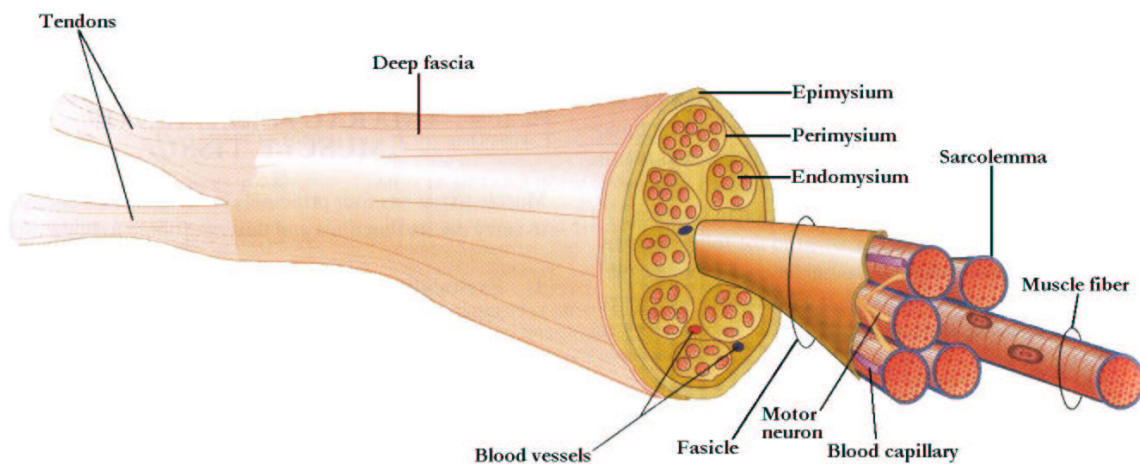
C. Skeletal

1. Long bundles of cells – striated
2. Multinucleated with nuclei at periphery of cells
3. Innervated by spinal or cranial nerves
4. Three types
 - a. red or dark (highest myoglobin and mitochondria content)
 - b. white or pale (lowest myoglobin and mitochondria content)
 - c. intermediate (characteristics between white and red fibers)
5. Skeletal muscle comprises majority of body muscle mass
6. Skeletal muscle fiber can run the length of the muscle with which it is a part
7. Skeletal muscle fibers do not branch or anastomose
8. Often described according to type of movement performed
 - a. Flexors – if they are located on the side of the limb towards which the joint decreases the joint angle
 - b. Extensors – if they are located on the side of the limb towards which the joint increases the joint angle
 - c. Adductors – if they pull a limb toward the median plane
 - d. Abductors – if they pull a limb away from the median plane
 - e. Sphincters – are arranged circularly to constrict body openings



III. Arrangement

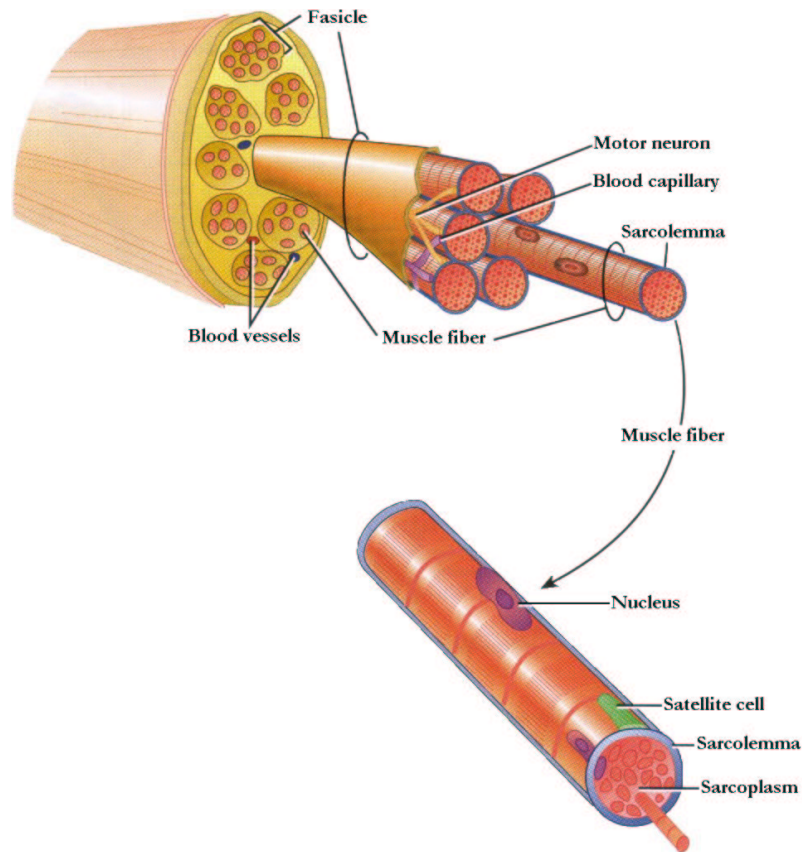
- A. Function of muscles is to contract or shorten and thereby move an object
- B. Primary consideration for accomplishing this goal is arrangement
- C. Examples include:
 - 1. Sheets
 - 2. Sheets rolled into tubes
 - 3. Bundles
 - 4. Rings
 - 5. Cones
 - 6. Discrete cells or clusters of cells
- D. The effects of skeletal muscles (apart from sphincters) are noted some distance from their location
 - 1. This means the contraction must be transmitted
 - 2. One end must be anchored and the other attached directly to a tendon or moveable part
 - 3. Accordingly, anatomic description of a skeletal muscle sometimes refers to its origin and insertion



IV. Skeletal Muscle Harnessing

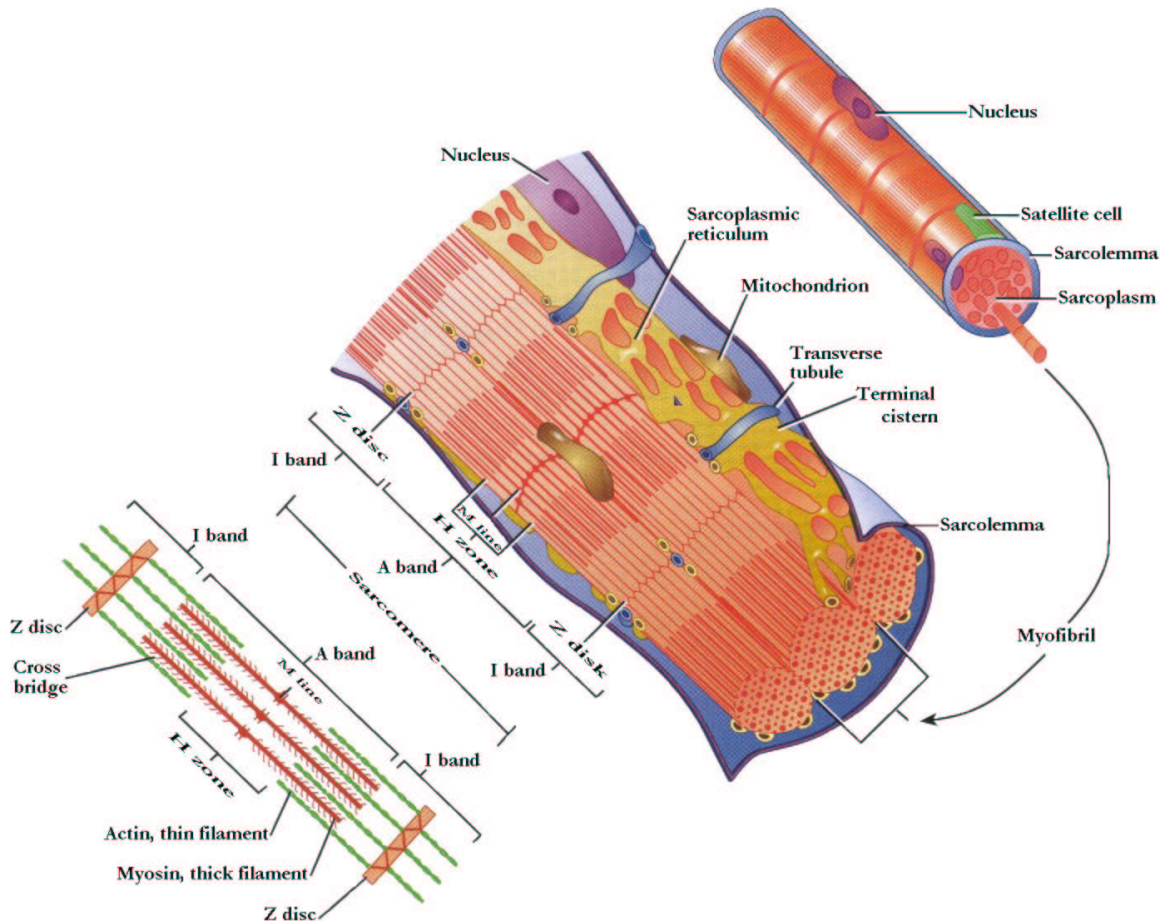
- A. Harness for skeletal muscle fibers is composed of connective tissue elements
 - 1. Epimysium
 - 2. Perimysium
 - 3. Endomysium
- B. Continuous from the individual muscle fibers to the connective tissue structure to which it attaches and on which it exerts its contraction
- C. Connective tissue elements of skeletal muscle are:
 - 1. Muscle fibers comprise a muscle bundle which are attached by their cell covering (sarcolemma) to connective tissue division, endomysium
 - 2. The endomysium is continuous with the connective tissue that envelops muscle bundles, the perimysium
 - 3. The perimysium is continuous with the connective tissue that envelops the muscle (collection of bundles), the epimysium

4. Then epimysium is continuous with the tendon or aponeurosis, which can travel some distance from its attachment

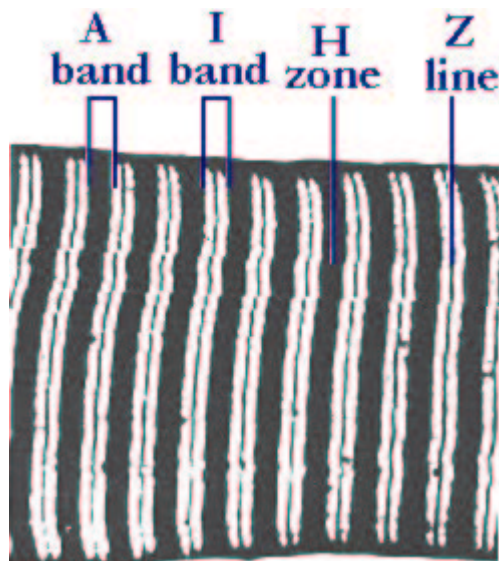


V. Microstructure of Skeletal Muscles

- A. Depending on diameter of the muscle fiber, there might be several hundred to several thousand myofibrils within one muscle
- B. Each myofibril has striations or banding
- C. Myofibrils are further broken into repetitive units (sarcomeres)
- D. Sarcomeres contain the protein myofilaments actin and myosin
 - 1. Give rise to striations by their arrangement
- E. Sarcomeres of a myofibril are in alignment with the sarcomeres of all the other myofibrils of the muscle fiber
- F. The Z line is located at each end of a sarcomere and is common to both sarcomeres that it separates
- G. Actin filaments project from the Z line into the sarcomeres that it separates
- H. Actin of two sarcomeres common to the same Z line comprise an I band



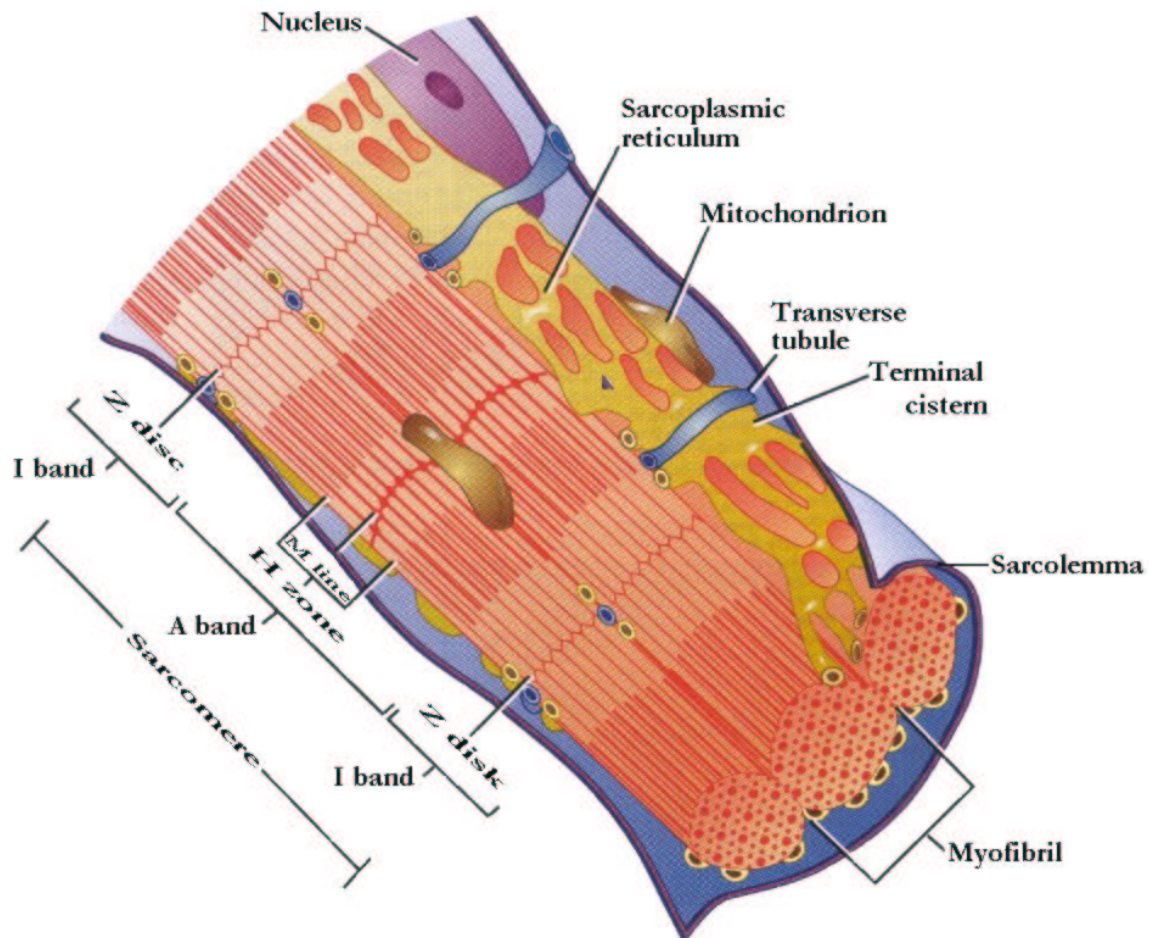
- I. The myosin filaments are centrally located within a sarcomere, coupled with the overlap of actin filaments provide for the dark banding (A band)
- J. There is a regular 2:1 ratio of actin to myosin



Photomicrograph of a longitudinal section of a skeletal muscle fiber.

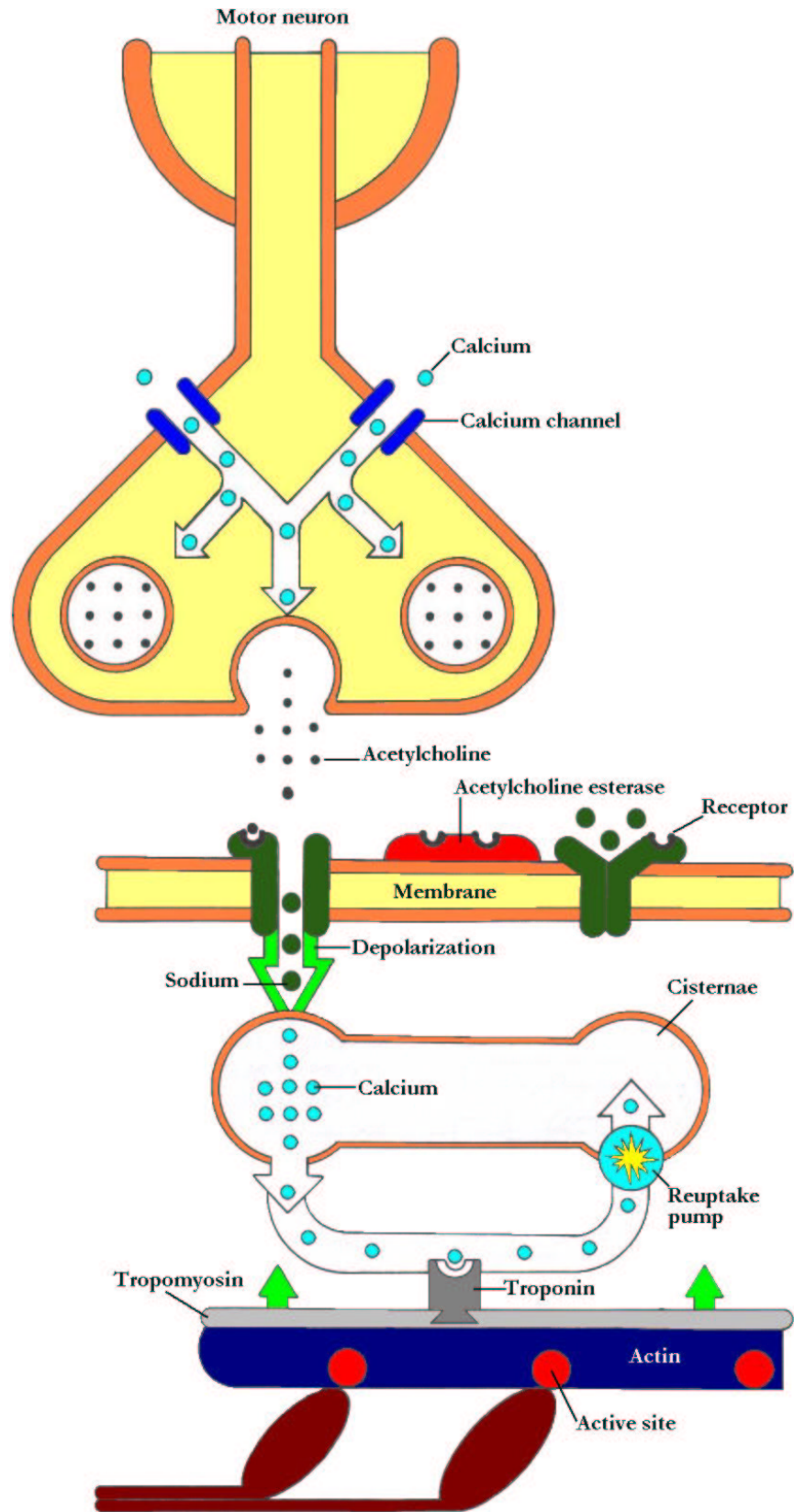
VI. Sarcotubular system

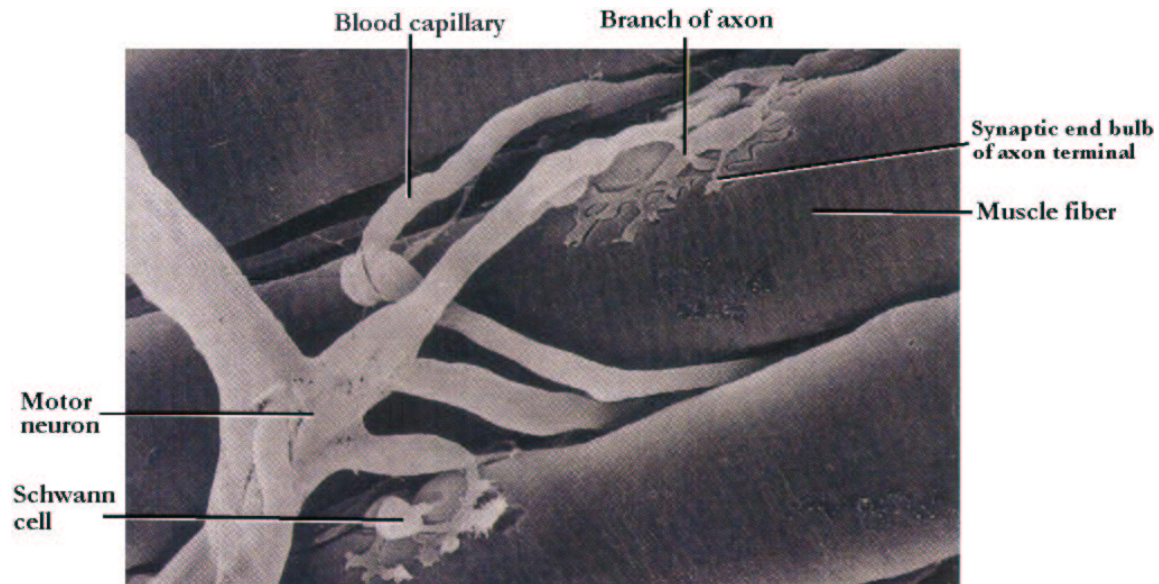
- A. Skeletal muscle fibers contain a network of tubules known as the sarcotubular system
- B. Tubules are located within the muscle fiber, but outside the myofibrils
- C. Two tubule sets
 1. Arranged transversely (right angles) to myofibrils
 2. Open to the outside of fibers
 - a. contain extracellular fluid
 3. Found at boundary of A and I bands
 - a. each sarcomere has two



VII. Neuromuscular Junction

- A. Each skeletal muscle fiber is innervated by a motor neuron
- B. Axon terminal end bulb forms synapse with muscle fiber
- C. Release of Acetylcholine (Ach) causes depolarization
- D. One motor neuron innervates many muscle fibers
 1. Motor unit
- E. Motor unit ration of 1:150 means one nerve fiber supplies 150 muscle fibers
- F. Smaller ration increases precision





VIII. Skeletal Muscle Contraction

A. Depolarization of muscle fibers

1. Acetylcholine released into synapse
 - a. Ca^{++} facilitates release
 - b. Parturient paresis occurs if not enough Ca^{++}
2. Opens ligand-coated Na^+ channels
3. Causes a propagated action potential
 - a. sarcolemma
 - b. T-tubule
 - c. sarcoplasmic reticulum
4. Cholinesterase destroys Ach
5. Depolarization of sarcoplasmic reticulum causes Ca^{++} release
6. Ca^{++} diffuses to myofibrils
7. Ca^{++} initiates contraction
8. Ca^{++} pumped back into sarcoplasmic reticulum
 1. active transport
 2. Ca^{++} ATPase Pump

